The automatic method of improving road photologging data quality and converting mashup GIS

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ABSTRACT

The road photologging system is frequently used because it is helpful to grasp the road situation and update data easily, In order to publish these data to the web, the mashup GIS method is needed. The mashup GIS is a new GIS service that mix the data with open map API(Application Programming Interface). It is important platform in web 2.0.

The CCD images of current mobile photologging system are stored more than tens of thousands images in one surveying time. But the quality of these images is inspected in a manual way. So it is difficult to find out poor image and improve the quality of these images.

In this study we researched the automatic improving method of photologging system and handling method of large number of image data rapidly and compared several image improving methods and converting time.

We also made GIS point data with these image data and integrated it to the current road management system and studied the method of publishing these data to web 2.0 environments in mashup GIS format like Google map and other GIS web site.

1. INTRODUCTION

Recently the mobile mapping system is utilized in many ways for its convenience and easy of updating. The road facility surveying system with photologging van in the United States started in 1970. The Wisconsin, New York and Connecticut Department of Transportation made use of photologging van in highway management. [1]

The Wisconsin DOT logged road photo images every 0.01mile (16.09m) and made record of State Highways. They keep those as digital photos. The location index was marked in road network map and used it as road and facility management. [1]

To calibrate these road photo images, generally auto image correction and post image processing method is needed. But the variation of brightness is so rapid that the post processing method takes a long time.

In this research we studied the rapid auto correction method which handled more than tens of thousands image at a time, and auto conversion method to GIS point data, utilizing method in mashup GIS which any user could add information in it.

The mashup is a web application which combines data or function from two or more sources into a single integrated application. The mashup implies easy, fast integration, frequently done by open APIs and data sources to produce results which are not the original raw source data. An example of a mashup is the use of cartographic data from Google Maps to add location information to real estate data, thereby creating a new and distinct Web service that is not originally provided by either sources. [2]

2. Road Photo Data Acquisition

Recently the road management system use road image logging system to grasp road alignment, pavement condition, and illegally installed road facilities. The road photologging system can provide location information, image, pavement, and cut-slope data. To collect these data Global Positioning System (GPS), Inertial Measurement Unit (IMU), Distance Measuring Instrument (DMI), and CCD camera were equipped in data collecting van and for road management system.

Figure 1 shows the photologging van. The exterior equipments consist of two GPS receivers, IMU, and DMI. This system collect precise location information data through post processing, and it send TTL(Transistor to Transistor Logic) 10m DMI signal to synchronizing unit. The inner unit consist of UPS, data backup computer, and camera control unit. It store the GPS, IMU, CCD camera data with 1m, 5m, 10m DMI signals.

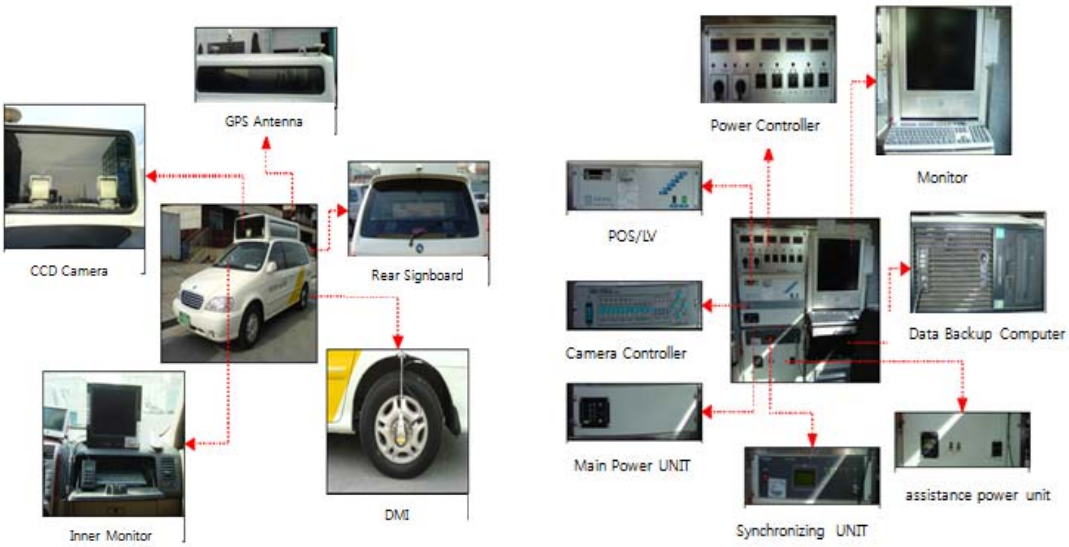

Figure 1. Mobile Photologging Van

The attached CCD cameras can acquire the road images with the 10m DMI trigger signal. To obtain the road position, this system makes use of one computer, four sensors(IMU, DMI, 2 GPS set). The acquired data is used in calculating the position and attitude data. The overall accuracy of positioning is 2㎝ in plane and 3㎝ RMSE error in vertical location with post processing.

The positioning sensor can be operated independently. We use LV-POSView S/W to monitor and grape the road image. The road image is stored in jpg format (150kb per one scene) every 10m along the road.

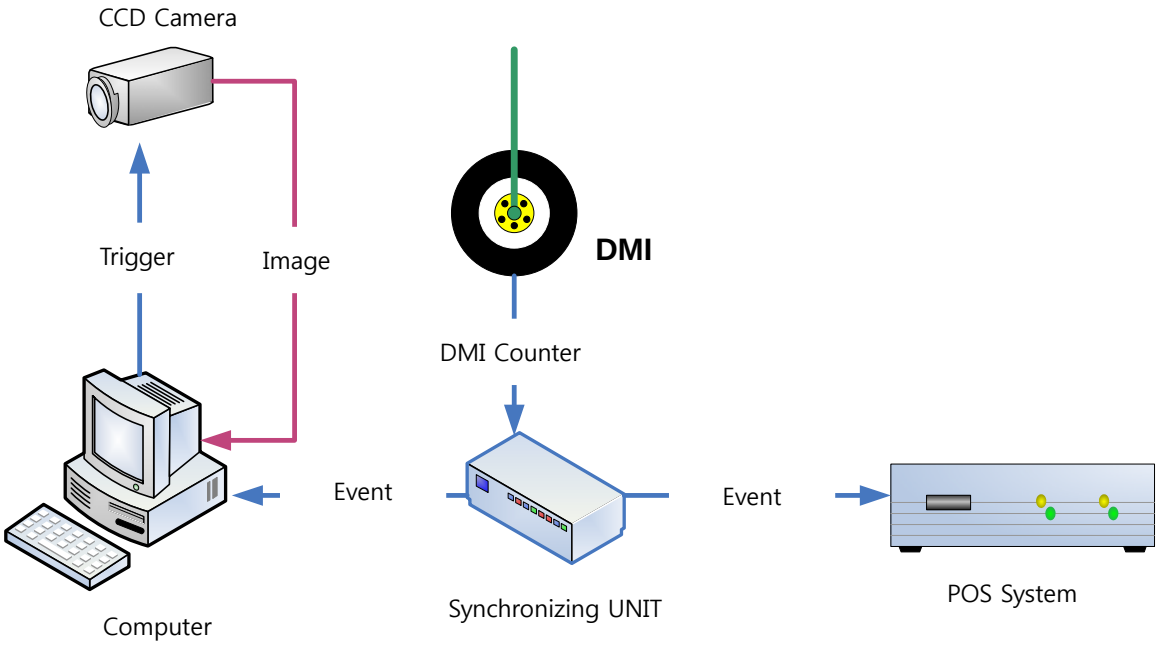

Figure 2. System Synchronizing Using DMI Count

To synchronize the signal, this system should be calibrated. This synchronizing unit accumulates the signal every 10m distance and transfer trigger signal to CCD camera and frame grabber in computer. At the same time, the event logs are stored with GPS times and the data of the position and attitude data.

The road images and positioning data are stored in database structure, and finally these DB table and road image files are uploaded to road image server.

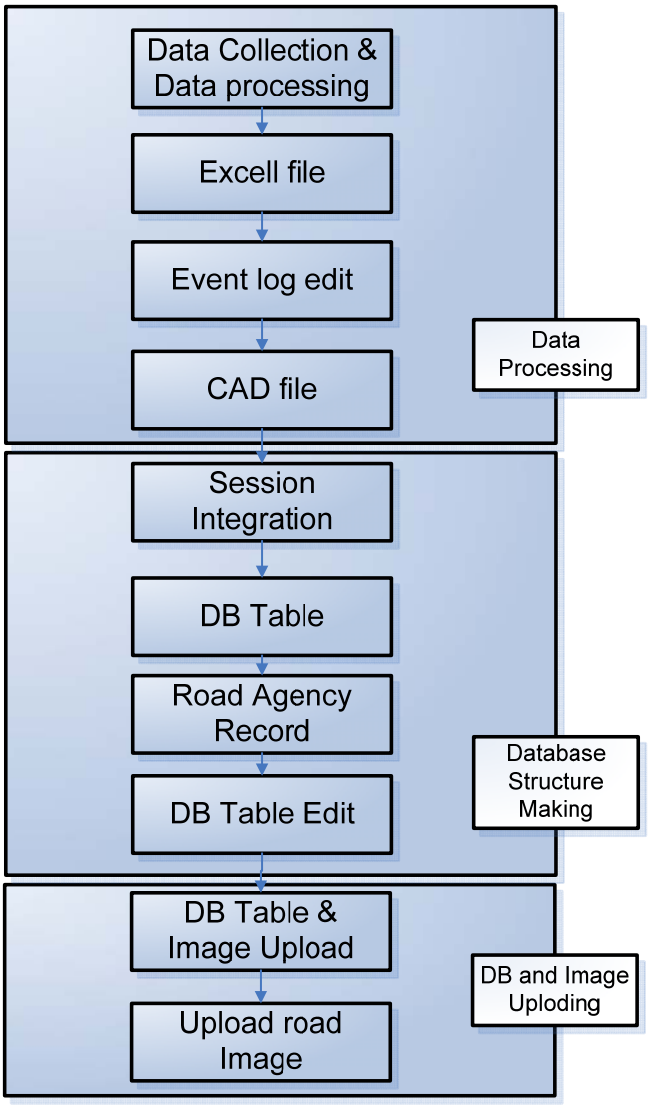

Figure 3. The Processing of Road Photologging System

In data processing, we calculated the position and attitude information with the POSPac S/W. The acquired data is positioning data, road image, serial communication data and facility information. To enhance the efficiency of processing, we combined the serial communication text file and facility information into excel file.

The processed session data is integrated and grouped with same route number. We structured DB table as following steps. 1) session integration, 2) DB Table generating, 3) editing the district agency code, 4) DB table editing,5) renaming image file name.

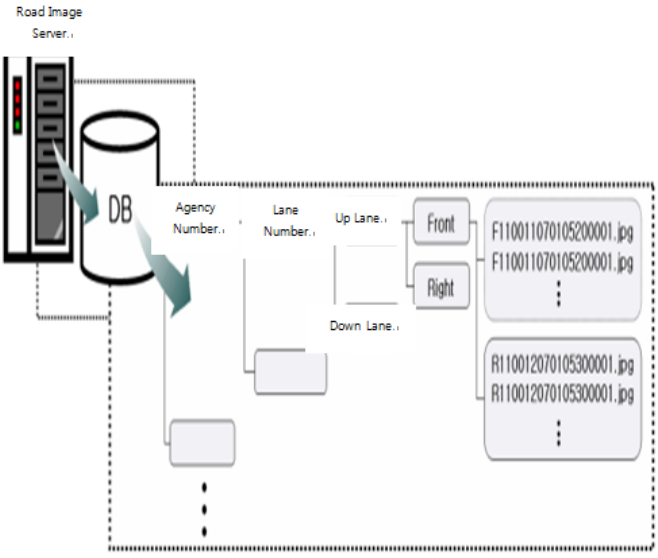

Figure 4. DB Structure

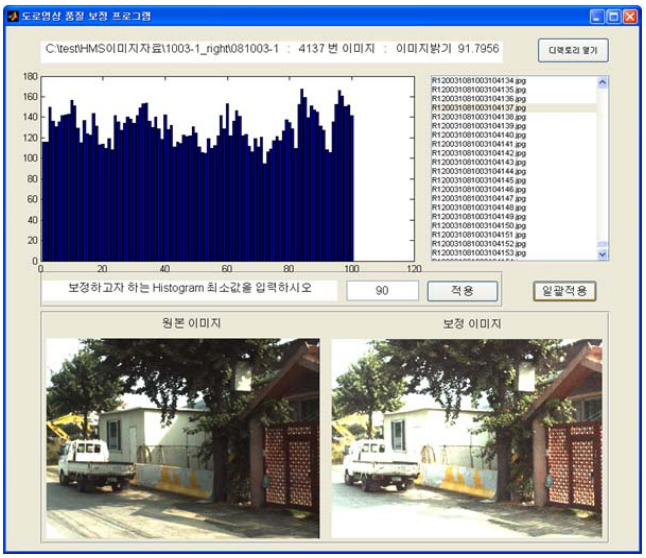

Figure 5. The Auto Image Enhancing Program

Figure 5 is the automatic image correction tools which is made by Matlab image processing toolbox. It automatically enhances the dark image in 30 minutes more than tens of thousands images at a time.

Also user can manually enhance the image one by one or automatically enhance the image by setting the low level contrast value.

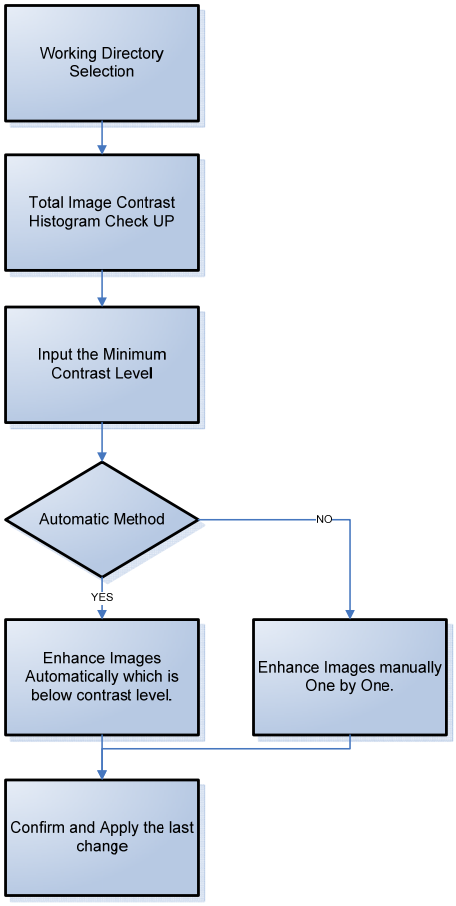

Figure 6. Auto Image Enhancing Workflow

Figure 6 shows image enhancement workflow. To inspect and enhance tens of thousands images in a short time, an automatic process is needed. This program can process all images in twenty to thirty minutes.

Figure 7 is the original image and histogram. The Image brightness value is under 150. Several tests were done to enhance these kinds of image contrasts.

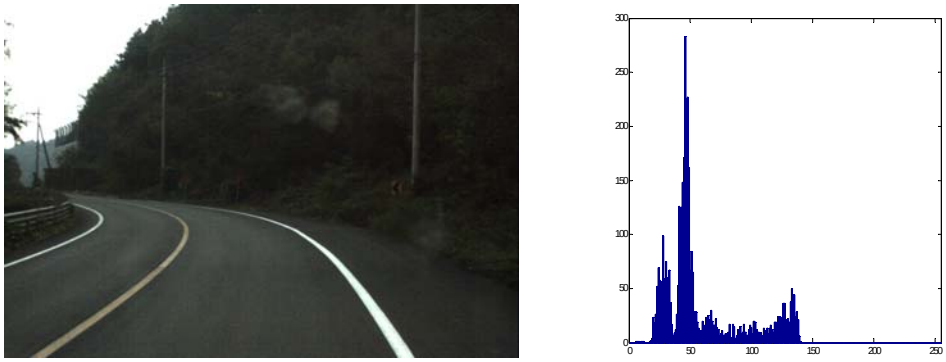

Figure 7. Original Image and Histogram

Figure 8 is the intensity transformation enhanced method. It rescale the image value region

from 0~0.5 to 0~1. It enlarged the image value to full extend. The intensity transformation function is the basic image processing tool in Matlab library for intensity transformations of grayscale images. This function maps the intensity values in image to new value such that value between low_input and high_input map to value between low_output and high_output. [3]

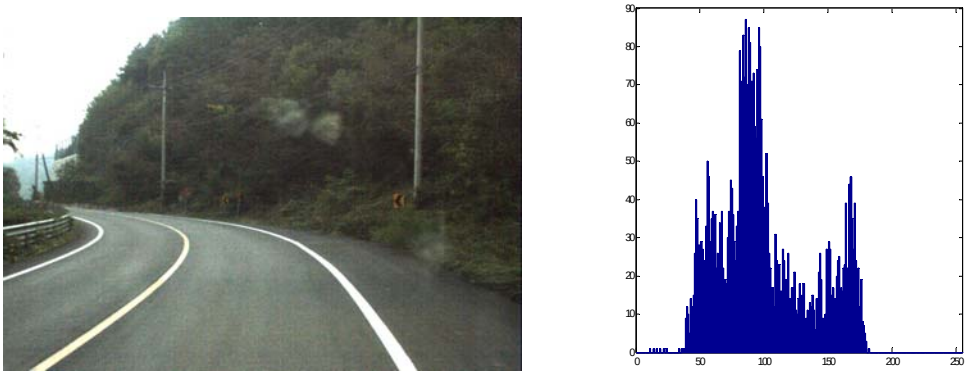

Figure 8. Intensity Transformation Enhanced Method

Figure 9 show the intensity transformation with Stretchlim method. Stretchlim function finds limits to contrast stretch of image. It gives the color definition. But it give us darker contrast than that of intensity transformation enhance method.

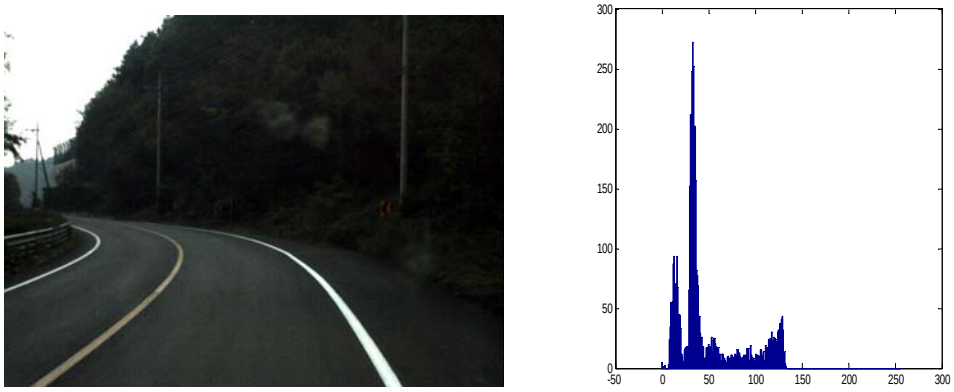

Figure 9. Intensity Transformation with Stretchlim Method

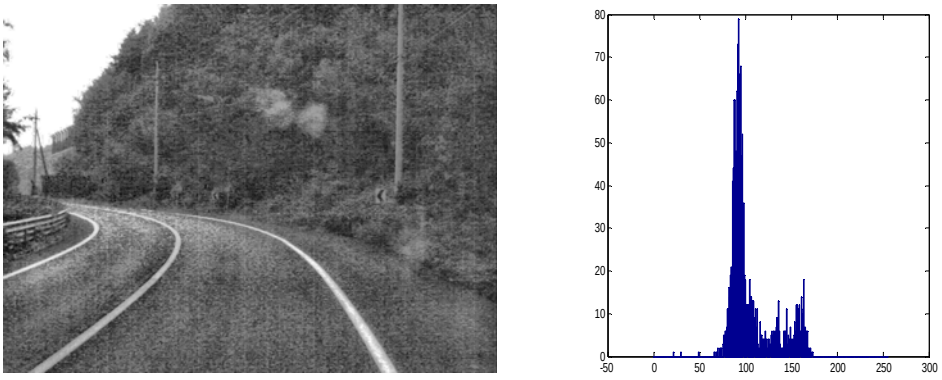

Figure 10. Logarithmic and Contrast-Stretching Enhancing Method

The logarithmic and contrast-stretching transformations are basic tools for dynamic range manipulation. Logarithm transformations are implemented using following equation.

$$s = T(r) = \frac{1}{1 + \left(\frac{m}{r}\right)^E}$$

Where, r is the intensities of the input image, s is the corresponding intensity value in the output image, and E controls the slope of the function. This function converts the input levels lower than m into a narrow range of dark levels in the output image. Similarly it converts the values above m into a narrow band of light levels in the output. The results are image with higher contras levels.[3]

Figure 11 shows the Histogram Equalization Method. It shows the similar scope of histogram to the scope of Figure 8. But it processes data in each RGB layer. The pattern of histogram was altered so that it was not suitable for this research.

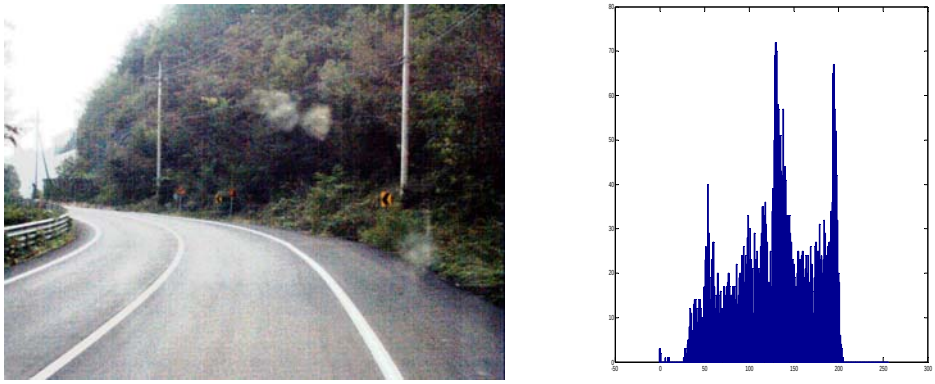

Figure 11. Histogram Equalization Enhancing Method

The Histogram Equalization process is quite simple. For each brightness level j in the original images the new assigned value k is calculates as

$$k = \sum_{i=0}^{j} N_i / T$$

Where, k is the new assigned value, T is the total number of pixel, and the sum counts the number of pixels in the image by integrating the histogram with brightness equal to or less than j.[4] Figure 11 show the widest image value histogram, but it takes time, so we selected image enhance model for intensity transformation method.

3. MashUp GIS methodology

In web development, the mashup is a web application that combines data or functionality from two or more sources into a single integrated application. The term mashup implies easy, fast integration, frequently done by access to open APIs and data sources to produce new results that were not from the original raw source data. [5]

In general the mashup technology is used for web application with the open API. In this research we used the famous open map API, Google map and mashup API. Anyone can insert Google map into his web pages, and can mark his own map information with this API.

Several years ago, to provide cartographic information for a web, application user must buy map data and images from map provider and request vendors to integrate the map database and web system. But Google mashup makes it easy to insert GIS data into web pages. The API provides a number of utilities for manipulating maps and adding contents to the map through a variety of services, which allow to create robust map applications on website.

The Google map updates frequently and it provides the latest road and large building

information. It can also display the aerial photo and streetview. If user follow the API standards, one can easily use the web based mapping system and data.

In this study, we obtained road alignment data from the precise GPS and IMU data. First, we set map projection to GRS80 which is used in Korea digital map projection system. Then we converted this alignment data to text file and import it to GIS program, and convert it to shape file format. Later we inserted image field names and matched the image filename with 10m scale. We made the image locations to GIS point data, and linked it with that point images.

The image can be seen by clicking the map point in the Google map. This process was necessary to convert KML(Keyhole Markup Language) which is a file format used to display geographic data in an web browser, such as Google Earth. Users can create KML files to pinpoint locations, add image overlays, and expose rich data. KML is an international standard maintained by the Open Geospatial Consortium (OGC).[5]

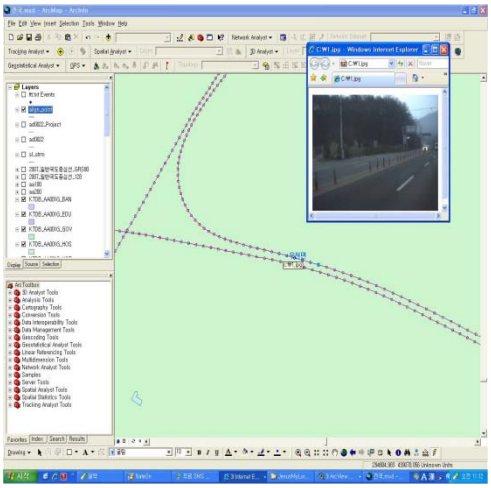

Figure 12. The Point Date with Image Location

Figure 13 . Difference of TM and GRS80

Figure 12 shows the GIS points are linked to image locations. When the point is clicked, the image is popped up. Figure 13 show the difference of TM(Transverse Mercator) and GRS(Geodetic Reference System) projection. It seemed that the GRS80 projection data is precise in Google Map projection and the TM projection data shows about 120m gap from the Google map. We found that the GRS80 map projection should be used in Google map. Figure 14 is the 3D road alignment overlay image. Figure 15 is the pit mouse of tunnel with 3D overlay image.

Figure 14. 3D Road Alignment View

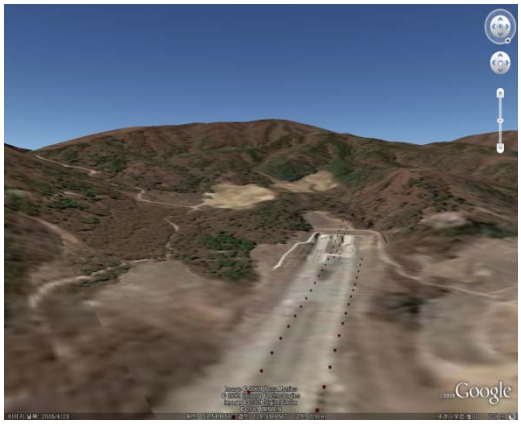

Figure15. Tunnel Overlaid Image

In Google earth, 3D image is easily made by KML. The KML file specifies a set of features to display in Google earth, or any other 3D earth browser implementing the KML encoding. Each place

always has a longitude and latitude. Other data can make the view more specific, such as tilt, heading, and altitude, which define a "camera view".

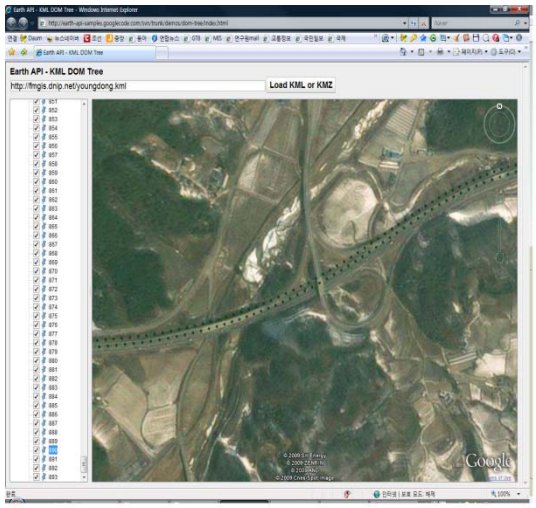

Figure 16. Point Layer

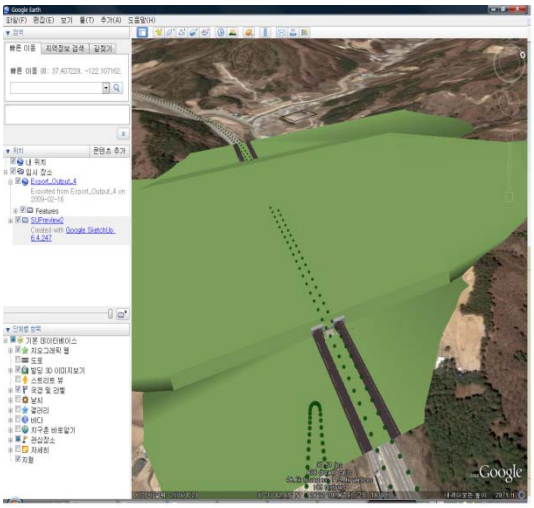

Figure 17. 3D Tunnel Object Overlay

We also made KML webpage with Google API. Figure 16 shows the each point layer information in web browser. Figure 17 show the 3D tunnel object overlaid in Google map. The tunnel object is created Google sketch program and inserted to Google earth.

In this study, we showed the method of how to make DB for road photologging system, how to enhance the image automatically, and how to make this data to Google Earth mashup GIS.

3. CONCLUSIONS

With the mashup GIS, we can provide our photologging data to web easily. We found the automatic contrast improving method using photologging system. By using this process the quality of contrasts for tens thousands of images were improved at a time.

We converted photologging image data into GIS point data automatically and inserted it into web page.

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